

**MSCS CONSERVATION MEASURES:** The following conservation measures are included in the Multi-Species Conservation Strategy (2000) to provide additional detail to ERP actions that would help achieve species habitat or population targets.

- Maintain process that support the dynamic habitat of Delta mudwort and Delta tule pea throughout the species range and associated with existing source populations.
- To the extent consistent with CALFED objectives, create unvegetated, exposed substrate at tidal margins of restored and created tidal fresh emergent wetland and riparian habitat.
- To the extent consistent with CALFED objectives, incorporate suitable habitat for these species into levee designs.
- Incorporate sufficient edge habitat to support the species in levee setback and channel island habitat restoration.
- Maximize sinuosity of restored and created slough channels to increase water-land edge habitat.
- Maintain and restore habitat and populations throughout the species geographic ranges and expand the species ranges to the historical and ecological ranges based on hydrological, salinity, and other habitat attributes.
- Monitor existing populations and their habitat at five year intervals

**RATIONALE:** *These two species inhabit freshwater and brackish marshes. Actions to enhance existing marsh habitats and to restore tidal marsh areas will contribute to the recovery of delta tule pea and delta mudwort.*

#### **DELTA COYOTE-THISTLE**

**MSCS SPECIES GOAL PRESCRIPTION:** Survey all extant populations and suitable habitat and update status and ownership information. Bring at least 10 of the largest extant, naturally occurring populations found during surveys into permanent protected status and bring at least 50% of all extant populations and individuals under permanent protected status. Manage protected populations for long-term viability. Increase suitable habitat by 50%

over existing extent. Increase population and individually by 25% over present existing conditions.

**MSCS CONSERVATION MEASURES:** The following conservation measures are included in the Multi-Species Conservation Strategy (2000) to provide additional detail to ERP actions that would help achieve species habitat or population targets.

- Survey all extant population and suitable habitat and update ecological, population, and ownership information.
- Bring at least 10 of the largest, extant, naturally occurring populations found during surveys into permanent protected status.
- Manage the protected populations for long-term viability. This measure includes research into appropriate management strategies.
- Establish and protect new populations in newly created floodplain habitat along the San Joaquin River and associated sloughs in Merced and Stanislaus Counties.
- Restore, enhance, and protect suitable habitat near existing populations and avoid impacts on existing populations to the greatest extent practicable during restoration activities.
- Monitor the status and distribution of all (natural and restored) populations at two-year intervals for the duration of CALFED and evaluate methods for active reintroduction into restored and enhanced habitat when natural colonization does not occur. Evaluate appropriate habitat management measures for maintaining suitable habitat.

**RATIONALE:** *Delta coyote-thistle occurs on clay soils on sparsely vegetated margins of seasonally flooded floodplains and swales, freshwater marshes and riparian areas. Actions to enhance and restore those habitat types will contribute to the recovery of Delta coyote-thistle.*

#### **ALKALI MILK-VETCH**

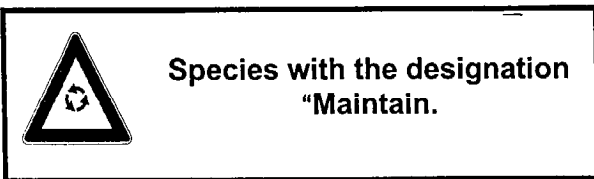
**MSCS SPECIES GOAL PRESCRIPTION:** Protect extant populations and reintroduce species near extirpated populations.

**MSCS CONSERVATION MEASURES:** The following conservation measures are included in the

Multi-Species Conservation Strategy (2000) to provide additional detail to ERP actions that would help achieve species habitat or population targets.

- Monitor status and distribution of populations and design and implement conservation measures if a decline in population size or vigor is observed.
- Protect extant populations and reintroduce species near extirpated populations.

**RATIONALE:** *Alkali milk-verb* is dependent on vernal pool habitat. Actions to protect, enhance, and restore vernal pools will contribute to the recovery of this species.



NOTE: The following species designated as "Maintain" all share the following common species goal prescription: **An increase in or no discernable adverse effect on the size or distribution of species populations.** Additionally, these species are covered by general conservation measures which broadly apply to each. A few species have specific conservation measures and they have been included.

#### GENERAL CONSERVATION MEASURES

- Conduct surveys in suitable habitat areas within portions of the species' range that could be affected by CALFED actions to determine the presence and distribution of the species before implementing actions that could result in take or loss or degradation of occupied habitat.
- Avoid or minimize (except as noted in specific species conservation measures) implementing CALFED actions that could result in or take of evaluated species or the loss or degradation of habitat occupied by evaluated species.
- Coordinate CALFED actions with U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game to avoid potential conflicts with existing and potential future CALFED actions that may be implemented to recover evaluated species.

- Coordinate CALFED actions with other federal, state, and regional programs (e.g., the San Francisco Bay Wetlands Ecosystem Goals Project, the Anadromous Fish Restoration Program, the Senate Bill (SB) 1086 program, the Corps' Sacramento and San Joaquin River Basins Comprehensive Study, the Riparian Habitat Joint Venture, the Central Valley Habitat Joint Venture, and the Grassland Bird Conservation plan) that could affect management of evaluated species to avoid potential conflicts among management objectives.
- Avoid implementing CALFED actions that could result in the substantial loss or degradation of suitable habitat in areas that support core populations of evaluated species and that are essential to maintaining the viability and distribution of evaluated species.
- CALFED actions that potentially could mobilize large quantities of toxic materials from the soil should include an analysis to determine the amount of contaminants that could be mobilized and, if released and contaminant loadings could be harmful to evaluated species, modify actions to the extent practicable to reduce loadings of mobilized contaminants.
- To the extent consistent with CALFED objectives, manage lands purchased or acquired under conservation easements to maintain or increase current population levels of resident evaluated species.

#### MAD-DOG SKULLCAP

**MSCS CONSERVATION MEASURE:** Conduct surveys in suitable habitat areas that could be affected by CALFED actions to determine whether species are present before implementing actions that could result in the loss or degradation of occupied habitat.

**RATIONALE:** *Mad-dog skullcap* inhabits mesic meadows and marshes and is known only from two locations in San Joaquin County. Actions to protect, enhance, or restore wet meadows or marshes can provide a means to maintain this native species in the ERP ecological management zones.

## ROSE-MALLOW

### MSCS CONSERVATION MEASURES:

- Avoid or minimize adverse effect on the ecological processes that support the dynamic habitat of rose mallow throughout the species' range and associated with existing source populations.
- Conduct research to determine the extent and physical and biological qualities of existing habitat and populations before implementing actions to rehabilitate or restore levees.
- To the extent consistent with ERP objectives, create unvegetated, exposed substrate at tidal margins of restored and created tidal fresh emergent wetland and riparian habitats.
- To the extent consistent with CALFED objectives, incorporate suitable habitat for this species into levee improvement, levee setbacks, and channel island habitat restoration designs.
- To the extent consistent with ERP objectives, maximize sinuosity of restored and created slough channels to increase water-land edge habitat.

**RATIONALE:** Rose-mallow is dependent on open, freshwater marsh habitats along the lower portions of the Sacramento and San Joaquin rivers. Action to improve and restore floodplain habitats and freshwater marshes will contribute to the recovery of this species.

## EEL-GRASS PONDWEED

**MSCS CONSERVATION MEASURE:** Conduct surveys in suitable habitat areas that could be affected by CALFED actions to determine whether species are present before implementing actions that could result in the loss or degradation of occupied habitat.

**RATIONALE:** Eel-grass pondweed is dependent on ditches, ponds, lakes, and slow-moving streams. Actions to protect, enhance and restore these aquatic habitats can assist in maintaining this native species.

## COLUSA GRASS

**MSCS CONSERVATION MEASURE:** To the extent consistent with ERP objectives, enhance or

restore suitable habitats to benefit Colusa grass in occupied habitat.

**RATIONALE:** Colusa grass is dependent on large or deep vernal pools with substrates of adobe mud. Actions to protect, restore, and enhance vernal pools will help maintain this native species.

## CONTRA COSTA GOLDFIELDS

**MSCS CONSERVATION MEASURE:** Conduct surveys in suitable habitat areas that could be affected by CALFED actions to determine whether species are present before implementing actions that could result in the loss or degradation of occupied habitat.

**RATIONALE:** Contra Costa goldfields is a vernal pool dependent species. Action to protect, enhance, and restore vernal pool will contribute to efforts to maintain self-sustaining populations of this native species.

## BOGGS LAKE HEDGE-HYSSOP AND GREEN'S LEGENERE

**MSCS CONSERVATION MEASURE:** To the extent consistent with ERP objectives, enhance or restore suitable habitats to benefit these species in occupied habitat areas.

**RATIONALE:** Actions to protect and restore vernal pool will help to maintain viable populations of these two vernal pool species

## RECURVED LARKSPUR AND HEARTSCALE

### MSCS CONSERVATION MEASURES:

- Develop a seedbank from all populations affected by implementation of CALFED actions and use the collected seed for inoculating unoccupied suitable habitat.
- To the extent consistent with ERP objectives, enhance or restore suitable habitats to benefit these species in occupied habitat areas.

**RATIONALE:** These two species will be maintained through action of protect and restore perennial grasslands.

## CALIFORNIA FRESHWATER SHRIMP

**MSCS CONSERVATION MEASURE:** To the extent consistent with ERP objectives, enhance or restore suitable habitats near occupied habitat areas.

**RATIONALE:** The recovery objectives for California freshwater shrimp are: (1) to recover and delist the shrimp when viable, self-sustaining populations and their habitat are secured and managed within all watershed harboring shrimp, and (2) to enhance habitat conditions for aquatic organisms that currently coexist or have occurred historically with the California freshwater shrimp.

Downlisting from endangered to threatened will be considered when: (1) a watershed plan has been implemented for each of four drainage units, (2) long-term protection is assured for at least one shrimp stream in each of the four drainage units, and (3) the abundance of California freshwater shrimp increases to over 2,000 individuals per stream in each of 16 streams harboring shrimp.

Delisting of California freshwater shrimp will be considered when: (1) a watershed plan has been implemented for each of four drainage units, (2) long-term protection is assured for at least eight shrimp stream with at least one in each of the four drainage units, (3) populations of California freshwater shrimp maintain stable or increasing populations of at least 2,000 individuals for at least 10 years in each of 16 streams harboring shrimp, and (4) at least 50 percent of shrimp-bearing streams have shrimp distributed over 8 kilometers (5 miles) or more (U.S. Fish and Wildlife Service 1997b).

## HARDHEAD

**MSCS CONSERVATION MEASURE:** No additional conservation measures are required to maintain this species.

**RATIONALE:** Actions to protect, enhance, and restore aquatic habitats throughout the ERP ecological management zones will improve conditions for the native hardhead and contribute to maintaining existing populations.

## WESTERN LEAST BITTERN

### MSCS CONSERVATION MEASURES:

- To the extent consistent with ERP objectives, design and manage wetland habitat restorations

and enhancements to provide suitable nesting and foraging habitat conditions.

- To the extent consistent with ERP objectives, restore wetland habitats adjacent to occupied nesting habitats to create a buffer zone of natural habitat to protect nesting pairs from potential adverse effects that could be associated with future changes in land use on nearby lands and to provide foraging and nesting habitat areas suitable for the natural expansion of populations.
- Avoid or minimize disturbances that could be associated with implementing CALFED actions near active nest sites during the nesting period (April-August).

**RATIONALE:** The western least bittern, a California Department of Fish and Game Species of Special Concern nests in emergent wetlands of cattails and tules in the upper and lower reaches of the Central Valley and winters in marshlands along the main rivers and in the Delta. Least bitterns were apparently once a common wintering bird in the Central Valley but are now scarce. The loss of wintering habitat as a result of channelization and reclamation of marsh lands along the major rivers and Delta has been a major factor in their decline.

## CALIFORNIA RED-LEGGED FROG

### MSCS CONSERVATION MEASURES:

- To the extent consistent with ERP objectives, enhance or restore suitable habitats near occupied habitat areas.
- Avoid or minimize CALFED actions that could increase or attract non-native predator populations to occupied habitat.

**RATIONALE:** Red-legged frogs are virtually extinct in the region, with just a handful of tenuous populations remaining in the Central Valley and bay region (none near the estuary). Their inability to recover from a presumed major population crash in the 19th century (due to overexploitation) has been the result of a combination of factors (in approximate order of importance): (1) predation and competition from introduced bullfrogs and fishes; (2) habitat loss, (3) pesticides and other toxins, (4) disease, and (5) other factors. Because of the poor condition of the few remaining frog populations and the continued existence of major causes of their decline, this

objective may not be achievable in either the short or long term.

## CALIFORNIA TIGER SALAMANDER

### MSCS CONSERVATION MEASURES:

- To the extent consistent with ERP objectives, enhance or restore suitable habitats near occupied habitat areas.
- Avoid or minimize CALFED actions that could increase or attract non-native predator populations to occupied habitat.

**RATIONALE:** California tiger salamander populations are disappearing rapidly in the Bay-Delta watershed because of habitat alteration, especially urban development, and introductions of non-native fishes into their breeding ponds. They require fish-free breeding ponds next to upland habitat containing rodent burrows in which they can over-summer. Patches of suitable habitats are naturally somewhat isolated from one another, promoting genetic diversity within the species which presumably reflects adaptations to local conditions. Long-term survival of these diverse populations depends on numerous protected areas containing both breeding ponds and upland habitats.

## WESTERN POND TURTLE

**MSCS CONSERVATION MEASURE:** To the extent practicable, capture individuals from habitat areas that would be affected by CALFED actions and relocate them to nearby suitable existing, restored, or enhanced habitat areas.

**RATIONALE:** The western pond turtle is the only turtle native to the Central Valley region and to much of the western United States. Although considered to be just one widely distributed species, it is likely that the pond turtle is a complex of closely related species, each adapted for a different region. The Pacific pond turtle is still common enough in the Bay-Delta watershed so that it is not difficult to find them in habitats ranging from sloughs of the Delta and Suisun Marsh to pools in small streams. The problem is that most individuals seen are large, old individuals; hatchlings and small turtles are increasingly rare. The causes of the poor reproductive success are not well understood but factors that need to be considered include elimination of suitable breeding sites, predation on hatchlings by non-native

predators (e.g., largemouth bass, bullfrogs), predation on eggs by non-native wild pigs, diseases introduced by non-native turtles, and shortage of safe upland over-wintering refuges. If present trends continue, the western pond turtle will deserve listing as a threatened species (it may already).

## WESTERN SPADEFOOT

### MSCS CONSERVATION MEASURES:

- To the extent consistent with ERP objectives, enhance or restore suitable habitats near occupied habitat areas.
- Avoid or minimize CALFED actions that could increase or attract non-native predator populations to occupied habitat.

**RATIONALE:** Spadefoot toad populations are disappearing rapidly in the Bay-Delta watershed because of habitat alteration, especially urban development, and introductions of non-native fishes into their breeding ponds. They require fish-free breeding ponds next to upland habitat in which they can burrow for over summering. These habitats are naturally somewhat isolated from one another, promoting genetic diversity within the species which presumably reflects adaptations to local habitat conditions. Long-term survival of spadefoot toad populations depends on protected areas containing both breeding ponds and upland habitats.



Species with the designation  
"Enhance and/or Conserve  
Biotic Communities."

**NOTE:** The following species are designated in the ERP as "Enhance and/or Conserve." These species are not covered by the MSCS and thus do not have MSCS species goal prescription or MSCS conservation measures.

## LAMPREY FAMILY

**POPULATION TARGET:** Evaluate the status and life history requirements of Pacific lamprey and river lamprey in the Central Valley and determine their use of the Delta and Suisun Bay for migration, breeding, and rearing.

**RATIONALE:** Lampreys are anadromous species that clearly have declined in the Central Valley although the extent of the decline has not been documented. Pacific lamprey probably exist in much of the accessible habitat available today but this is not known. The decline of lampreys is presumably due to deterioration of their spawning and rearing habitat, to entrainment in diversions, and to other factors affecting fish health in the system.

### **NATIVE RESIDENT FISHES**

**POPULATION TARGET:** Maintain self-sustaining populations of all native resident fishes throughout their native ranges in the ERP Ecological Management Zones.

**RATIONALE:** The Central Valley has a native resident fish fauna that is largely endemic to the region. Some species are extinct (thicktail chub) or nearly extinct (Sacramento perch) in the wild. While some native species (e.g., Sacramento pikeminnow [squawfish], Sacramento sucker) are clearly thriving under altered conditions, others are not (e.g., hitch, Sacramento blackfish, hardhead). There is a need to determine if some have unique problems or requirements that will prevent them from responding to general habitat improvements.

### **NATIVE ANURAN AMPHIBIANS**

**POPULATION TARGET:** Maintain self-sustaining populations of all native anuran amphibians throughout their native ranges in the ERP Ecological Management Zones.

**RATIONALE:** The native frogs and toads in the ERP focus area are in a general state of decline. Actions to reduce pesticide use and control or eliminate introduced frogs such as the bullfrog, will help maintain the diversity of these species in the ERP Ecological Management Zones.

### **WATERFOWL**

**POPULATION TARGET:** Improve populations and distribution of waterfowl.

**RATIONALE:** Waterfowl resources will be enhanced by protecting existing and restoring additional seasonal, permanent, and tidal wetlands. Improved management of agricultural lands using wildlife friendly methods will contribute to sustaining waterfowl resources in the Bay-Delta. The focus for

seasonal wetlands should be in areas that may be too deep for tidal marsh restoration over the next 20 years. In concert with efforts to reduce or reverse subsidence, selected areas or islands would be managed as waterfowl habitat. Besides increasing waterfowl resources, efforts to sustain waterfowl and their habitat will help offset some of the effects of converting agricultural or seasonal wetlands to tidal action when such actions may reduce the value of an area to waterfowl such as white-fronted geese or mallard. Efforts should also be focused on improving waterfowl nesting success by improving nesting and brood habitat. Improving waterfowl populations will be done in a manner that reduces conflict with broader ecosystem restoration goals or with goals to recover endangered species. For example: Flooding of rice fields for waterfowl in late winter may require water needed by migratory salmon. Careful management of the amount and timing of those diversions and the manner in which the diversions occur (e.g. through screened diversions) can help reduce conflicts. Management of waterfowl areas will occur using management strategies developed for existing and new waterfowl areas that provide benefits to at-risk species.

### **SHOREBIRD GUILD**

**POPULATION TARGET:** Improve populations and distribution of shorebirds.

**RATIONALE:** Loss and degradation of wetland and aquatic habitats used by wintering and migrant shorebirds in the Central Valley is a factor limiting populations of these species. Large-scale restorations of these habitats will increase the available foraging habitat area to better accommodate existing populations and potential future expansions of shorebird populations.

### **WADING BIRD GUILD**

**POPULATION TARGET:** Improve populations and distribution of wading birds.

**RATIONALE:** Substantial loss and degradation of aquatic, wetland and riparian habitats used by wintering and resident wading birds in the Central Valley is a factor limiting populations of these species. Large-scale restorations of these habitats will increase the available foraging, roosting, and nesting habitat area to better accommodate existing

populations and future potential expansions of wading bird populations.

### NEOTROPICAL MIGRATORY BIRDS

**POPULATION TARGET:** Increase the abundance and distribution of neotropical migratory birds in the Central Valley.

**RATIONALE:** Neotropical migratory birds constitute a diverse group of largely passerine songbirds that overwinter in the tropics but breed in or migrate through the Central Valley and Bay-Delta region. As a group, they are in decline because of loss of habitat on their breeding grounds, in their migratory corridors, and in their wintering grounds. The species within this group are good indicators of habitat quality and diversity and their popularity with birders means that populations are tracked and have high public interest. They can also be good indicators of contaminant levels, by monitoring reproductive success and survival in areas near sources of contamination. Riparian forests are particularly important to this group because they are major migration corridors and breeding habitat for many species. By providing improved nesting and migratory habitat, it may be possible to partially compensate for increased mortality rates in the wintering grounds.

### BAY-DELTA FOODWEB ORGANISMS

**POPULATION TARGET:** Increase populations and distribution of important foodweb organisms in Delta channels and reduce competition with invasive non-native species.

**RATIONALE:** The population target is quite likely impossible to achieve because recent invading species, from the Asiatic clam to various crustacean zooplankters, will continue to play major ecological roles in the system, to the detriment of native organisms. However, at the very least it is possible to stop further introductions of non-native species which have the potential to further change the system unpredictably. This target is also a call to develop a thorough understanding of the planktonic portion of the Bay-Delta system to predict and understand the impacts of large-scale ecosystem alteration projects on the plankton.

## PLANT COMMUNITIES

**POPULATION TARGET:** For all plant communities, maintain the present distribution and abundance and ensure self-sustaining communities in the long-term.

**RATIONALE:** Native plant communities are composed of a diversity of groups including aquatic habitat, tidal brackish and freshwater habitat, seasonal wetland habitat, inland dune habitat, and tidal riparian habitat plant communities. Overall, actions in the ERP Ecological Management Zones to improve ecological process and protect, enhance or restore habitats will contribute to maintaining the diversity and abundance of plant community groups.



**Species with the designation  
"Maintain and/or Enhance  
Harvested Species."**

NOTE: The following species are designated and "maintain and/or enhance harvested species" in the ERP. These species are not covered in the MSCS and thus do not have MSCS species goal prescriptions or MSCS conservation measures.

### WHITE STURGEON

**POPULATION TARGET:** Meet Native Fish Recovery Plan goals (U.S. Fish and Wildlife Service 1996), which include 100,000 white sturgeon and 2,000 green sturgeon greater than 100 centimeters long as measured in the DFG mark-recapture program.

**RATIONALE:** White sturgeon represent an unusual situation: a success story in the management of the fishery for a native species. Numbers of sturgeon today are probably nearly as high as they were in the nineteenth century before they were devastated by commercial fisheries. The longevity and high fecundity of the sturgeon, combined with good management practices of the California Department of Fish and Game, have allowed it to sustain a substantial fishery since the 1950s, without a major decline in numbers. Numbers of white sturgeon could presumably be increased if the San Joaquin River once again contained suitable habitat for spawning and rearing.

## STRIPED BASS

**POPULATION TARGET:** Restore the adult population (greater than 18 inches total length) to 1.1 million fish within the next 10 years. In addition, all measures will be taken to assure that striped bass restoration efforts do not interfere with the recovery of threatened and endangered species and other species of special concern covered under public trust responsibilities.

**RATIONALE:** The striped bass is a non-native species that is a favorite sport fish in the estuary. It is also the most abundant and voracious piscivorous fish in the system and it has the potential to limit the recovery of native species, such as chinook salmon and steelhead. Therefore, the management for striped bass must juggle the objectives of providing opportunities for harvest while not jeopardizing recovery of native species. An appropriate policy may be to allow striped bass to increase in numbers as estuarine conditions permit but not to take any extraordinary measures to enhance its populations, especially artificial propagation. Artificially reared bass have the potential to depress not only native fish populations but also populations of wild striped bass, because larger juveniles (of hatchery origin) may prey on smaller juveniles (of wild origin). If increases in bass numbers appear to adversely affect recovery of native species, additional management measures may be required to keep bass numbers below the level that pose a threat to native species.

## AMERICAN SHAD

**POPULATION TARGET:** The target for American shad is to maintain production of young as measured in the fall midwater trawl survey and targets of the Anadromous Fish Restoration Program (US Fish and Wildlife Service 1997, in preparation). Specifically, the index of young American shad production should increase, especially in dry water years.

**RATIONALE:** The American shad is a non-native species that is an important sport fish in the estuary and its spawning streams, although less seems to be known about its life history in the estuary than any other major game fish. It is a common planktivore and occasional piscivore in the system and it may have the potential to limit the recovery of native species, such as chinook salmon. Therefore, the management for American shad must juggle the objectives of providing opportunities for harvest

without jeopardizing recovery of native species. An appropriate policy may be to allow American shad to increase in numbers as estuarine conditions permit but not to take any extraordinary measures to enhance its populations, especially flow releases specifically to favor shad reproduction. If increases in shad numbers appear to adversely affect recovery of native species, additional management measures may be required to keep shad numbers below the level that pose a threat to native species.

## NON-NATIVE WARMWATER GAMEFISH

**POPULATION TARGET:** Increase our knowledge about warmwater sport fishes in the Delta, Suisun Marsh, riverine backwaters, and elsewhere to find out their interactions with native fishes, limiting factors, and their contaminant loads (for both fish and human health).

**RATIONALE:** White catfish, channel catfish, brown and black bullhead, largemouth bass, and various sunfishes are among the most common fishes caught in the sport fishery in the Delta, Suisun Marsh, riverine backwaters, reservoirs, and other lowland waters. Although this fishery is poorly documented, it is probably the largest sport fishery in central California in terms of people engaged in it and in terms of numbers of fish caught. There is no sign of overexploitation of the fishes, although some (e.g., white catfish) have remarkably slow growth rates, indicating vulnerability to overexploitation. The fishes and the fishers are always going to be part of the lowland environment and deserve support of the management agencies. However, habitat improvements that favor native fishes, especially improvements that increase flows or decrease summer temperatures, may not favor these game fishes. The effects of the various CALFED actions on these fish and fisheries need to be understood, as do the interactions among the non-native fishes and the native fish CALFED is trying to protect.

## PACIFIC HERRING

**POPULATION TARGET:** Increase abundance of marine/estuarine fish and large invertebrates, particularly in dry years.

**RATIONALE:** Pacific herring support the most valuable commercial fishery in San Francisco Bay. This seasonal, limited-entry fishery focuses on spawning fish, for the fish themselves, their roe, and



kazunoko kombu (herring eggs on eel grass). It seems to be an example of successful fishery management because it has been able to sustain itself through a series of years with highly variable ocean and bay conditions. An important connection to the ERP is that highest survival of herring embryos (which are attached to eel grass and other substrates) occurs during years of high outflow during the spawning period; the developing fish seem to require a relatively low-salinity environment. There is also some indication that populations have been lower since the invasion of the Asiatic clam into the estuary, with the subsequent reduction in planktonic food organisms. Given the frequent collapse of commercial fisheries (including those for herring) in the modern world, it is best to manage this fishery very cautiously to make sure it can continue indefinitely.

### **GRASS SHRIMP**

**POPULATION TARGET:** Maintain grass shrimp populations at present levels as a minimum to support the existing commercial fisheries. Determine factors regulating their populations in order to discover if the fisheries conflict with other ecosystem restoration objectives.

**RATIONALE:** Grass shrimp are a mixture of native and introduced species that support a small commercial fishery in San Francisco Bay, largely for bait. The relative abundance of the various species as well as their total abundance appears to be tied in part to outflow patterns. It is likely that these abundant shrimp are important in Bay-Delta food webs leading to many other species of interest. The role of these shrimp in the Bay-Delta system and the effects of the fishery on that role need to be investigated.

### **SIGNAL CRAYFISH**

**POPULATION TARGET:** Maintain signal crayfish populations at present levels, in order to support the existing fisheries.

**RATIONALE:** The signal crayfish is an introduced species that supports a small commercial fishery, as well as a recreational fishery, in the Delta. It has been established in the Delta for nearly a century and appears to be integrated into the Bay-Delta system, appearing as a major food item for otters and some fish. The signal crayfish has fairly high water quality requirements so its populations will presumably

increase as water quality in the freshwater portions of the Delta improves. Its role in the ecosystem and the effects of the fishery on that role need to be investigated.

### **UPLAND GAME**

**POPULATION TARGET:** Increase the populations and distribution of upland game.

**RATIONALE:** Upland game are supported by diverse agricultural and upland habitats. The key to maintaining these species is by maintaining the habitats upon which they depend.

Table 4. Ecological Management Zones in which programmatic actions are proposed that will assist in the recovery of species and species groups.

Species and Species Group Visions	Ecological Management Zone <sup>1</sup>													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
<b>Species with the Designation "Recover"</b>														
Delta Smelt	●	●												
Longfin Smelt	●	●										●		
Green Sturgeon	●	●	●					●						
Sacramento Splittail	●	●	●					●	●		●	●		
Winter-run Chinook Salmon	●	●	●	●	●		●	●	●	●	●	●	●	
Spring-run Chinook Salmon	●	●	●								●	●	●	
Fall-run Chinook Salmon (including late-fall-run)	●	●	●	●	●		●	●	●	●	●	●	●	
Steelhead Trout	●	●	●	●	●		●	●	●	●	●	●	●	
Mason's Lilaepsis	●	●							●	●				●
Suisun Marsh Aster	●	●												
Suisun Thistle		●												
Soft Bird's-Beak		●												
Antioch Dunes Evening-Primrose and Contra Costa Wallflower		●												
Lange's Metalmark butterfly	●	●												
Valley Elderberry Longhorn Beetle	●	●	●	●	●									
Suisun Ornate Shrew		●												